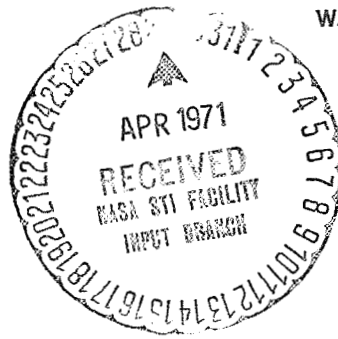




NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON, D.C. 20546

REPLY TO  
ATTN OF: GP



March 27, 1971

TO: USI/Scientific & Technical Information Division  
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General  
Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned  
U.S. Patents in STAR

In accordance with the procedures contained in the Code GP to Code USI memorandum on this subject, dated June 8, 1970, the attached NASA-owned U.S. patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3,340,430

Corporate Source : Kennedy Space Center

Supplementary  
Corporate Source : \_\_\_\_\_

NASA Patent Case No.: XKS-03381

Gayle Parker

Enclosure:  
Copy of Patent

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NASA-HQ

Sept. 5, 1967

K. H. JENKINS

3,340,430

DIODE AND PROTECTION FUSE UNIT

Filed March 5, 1965

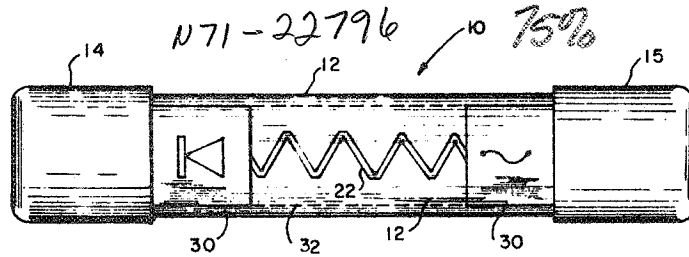


FIG. 1

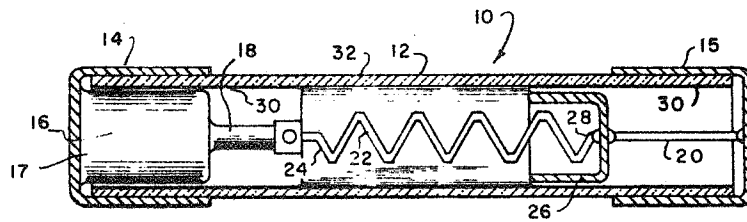


FIG. 2

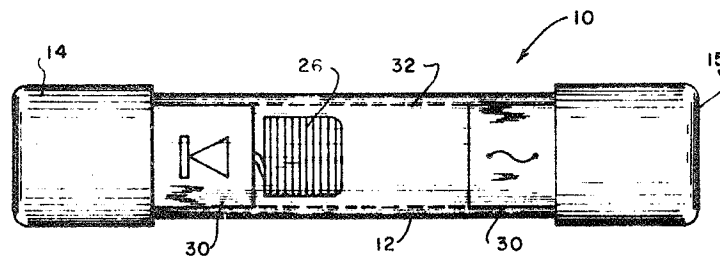


FIG. 3

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3,340,430

## DIODE AND PROTECTION FUSE UNIT

Keith H. Jenkins, Huntsville, Ala., assignor to the United States of America as represented by the Administrator of the National Aeronautics and Space Administration  
Filed Mar. 5, 1965, Ser. No. 437,611  
6 Claims. (Cl. 317-9)

## ABSTRACT OF THE DISCLOSURE

This unit combines a diode, fuse, and "blown" indicator into a single electrical circuit component. The unit includes an elongated tube fabricated from a transparent heat resistant material. Electrically conductive end caps close the tube and layers of opaque material coat the interior one third the length of the tube from each of its ends. The diode and fuse wire are secured to the respective end caps with a spring and indicator providing an electrical connection between them. The indicator is normally hidden behind the opaque material. If the fuse wire melts due to an excess of electrical current, the spring moves the indicator element to the transparent portion of the tube.

The invention described herein was made by an employee of the United States Government and may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a diode and more particularly relates to a semiconductor diode which is combined with a circuit breaking protective device such as a fuse.

Diodes fabricated of semiconductor material have found wide-spread application in electrical circuits especially where compactness and low power considerations are important. For example, they are widely used as rectifiers in the secondaries of power transformers found in many types of communications equipment such as television and radio receivers. They have also been found to be useful in suppressing noise produced by arcing across the actuation switch of relays when the switch is opened. In the latter application the diode because of its characteristic of permitting only unidirectional current flow provides a low resistance path for current produced by the collapse of the magnetic field around the relay coil without affecting the normal current flow path. This diode is connected in parallel with the relay coil so that as the relay actuation switch is opened, the current produced by the collapsing field circulates through the diode and the coil until it is dissipated. Hence, no electrical charge builds up on the contacts of the switch which could cause an arc.

When the diode is used in a manner similar to those set forth above it is generally remote from circuit protective fuses or circuit breakers. It is easily seen then, that a short across the diode will result in an excessive load on the power source causing a main fuse or circuit breaker to open. Placing a fuse in the circuit with the diode, however, adds to the number of components, complicates wiring, increases bulk and weight, and generally mitigates the advantages originally obtained by the use of a semiconductor device.

According to the instant invention it has been found that the advantages inherent in the uses of diodes fabricated from semiconductor material may be retained and a circuit protecting fuse may be employed without the attendant increase in bulk and weight which results from the use of a separate circuit breaking component. This is accomplished by utilizing a cartridge in which the diode and fuse are both incorporated and connected into a compact circuit component. The fuse is preferably of a type

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which has an indicator device incorporated therewith so that should it become "blown" such condition may be readily ascertained.

Accordingly it is an object of this invention to provide a diode fabricated from semiconductor material combined with a circuit breaking device.

It is another object of this invention to provide a fused diode which is not attended by a bulky and relatively heavy separate circuit component.

These and other objects and advantages of this invention will be more apparent upon reference to the following specification, appended claims, and drawings wherein:

FIGURE 1 is a longitudinal side view of a cartridge containing a diode and a fuse in accordance with the instant invention and showing the fuse in an unblown state;

FIGURE 2 is a longitudinal partly sectional view showing the components contained within the cartridge in the normal position for use; and

FIGURE 3 is a view similar to FIGURE 1 but showing the condition of the cartridge according to the instant invention when the fuse wire has blown.

In order to better understand the construction and use of this novel device, it will be described in relation to a fuse element combined with a semiconductor diode. It is to be understood, however, that this novel concept will find application whenever it is deemed desirable to provide circuit protection from the shorting of a single component only as opposed to protection from a short at any point within the circuit. These other uses will be readily apparent to those skilled in the art.

With continued reference to the accompanying figures wherein like numerals designate the similar parts throughout the various views, and with initial attention directed to FIGURE 1, reference numeral 10 designates generally a cartridge shaped container including a tubular portion 12 fabricated from a transparent material such as glass or a heat resistant synthetic resin, and electrically conductive end caps 14 and 15 secured thereto in a manner well known in the art. Suitably secured, as by welding or soldering, to the end cap 14 is an electronic component such as a diode unit 16 having a connector tab 18 secured thereon as an electrically conductive contact point. The end cap 15 mounted at the opposite end of the tube 12 is electrically connected to a fuse element or wire 20 which will melt when subjected to a current load higher than that which it is designed to carry in a manner well known in the art.

A spring 22 fabricated from an electrically conductive material such as copper or beryllium, is disposed within the tube 12 with one end 24 connected to the tab 18. Also disposed within the tube 12 is a cup-shaped indicator element 26 connected both to the fuse wire 20 and the other end 28 of the spring 22, and biased by the spring away from the fuse wire toward the diode.

As illustrated, the indicator 26 is fabricated from an electrically conductive material. It is obvious, however, that the indicator may be constructed of a nonconductive material with a connection between the spring 22 and the fuse wire 20 running directly through it.

The opposed ends of the transparent tube 12 are coated with opaque layers of material 30, such as a heat resistant paint, that extend approximately one third of the tube length from each end to conceal at one end the fuse wire 20 and the indicator 26, and at the other end the diode unit 16. Thus, when an excessive surge of current passes through, and melts the fuse wire 20, the spring 22 will pull the indicator 26 from behind the opaque layer 30 at one end of the tube into the clear center third 32 of the tube 12 so that it may be readily seen by visual inspection of the cartridge. As shown in FIGURE 3 the indicator is painted a distinctive color, such as red, to enhance its visibility.

The diode unit 16 may be any of the usual types such as P-N junction, point contact, or metallic and of itself forms no part of the invention. Current flow to the diode is provided through the tab 18 as one connection point and through another conductive external connection point at the junction 17 between the diode unit 16 and the end cap 14.

Since the fuse wire 20 is utilized to provide protection from a short within the diode itself, it is, as a rule of thumb, constructed so as to have twice the current carrying capacity of the diode. For example, if the diode is rated at 750 milliamps the fuse wire 20 should have a capacity of approximately 2 amps.

An example of a circuit in which this diode fuse combination is found useful is the actuation circuit for a relay as described above. In order to prevent arcing across the switch which controls the flow of current through the coil of such a relay and, therefore, suppress radio noise, the diode-fuse combination is placed in parallel with the coil. The diode is arranged such that little or no current will flow through it during the time the actuation switch is closed and current is flowing through the coil. In order to facilitate this positioning markings are provided on the exterior of the cartridge 10 as shown in FIGURES 1 and 3. As the actuation switch is opened the field collapsing around the coil produces a current which flows in a direction opposed to that which would be considered normal. This collapsing field will produce a charge on the open side of the switch which might cause an arc unless effectively dissipated. The diode prevents the building of a charge by forming a low resistance path for current through it and the coil thereby forming a circular current flow which continues until the charge is dissipated.

If the diode in such a circuit should become shorted and there was no fuse for protection, the remainder of the circuit would be rendered completely inoperative and therefore the relay would be put out of service. Where the fused diode of the instant invention is utilized, however, the parallel circuit merely becomes open if the diode is shorted and the relay will continue to be operative even though there will be then some danger of arcing across the coil actuation switch. In a large rocket powered space vehicle system where there are literally thousands of relays and where it is very important that none of them fail, a fused diode such as that described herein is invaluable.

It will be apparent that by utilizing the teachings of this invention a circuit component combining the features of both a diode and a fuse can be produced. The combination of these two features within one component greatly reduces the bulkiness and weight required should separate components be utilized. Obviously, savings in weight and bulk are very desirable in the design of all types of aircraft including rocket powered space vehicles. Furthermore, the cost of the component mounting hardware and fabricating of the finished assembly will be considerably less than that obtainable under present methods.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is, therefore, to be considered in all respects illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A device adapted to be utilized in an electrical circuit comprising:

- (a) a container
  - (1) having a transparent portion and
  - (2) including at least two electrically conductive contact points insulated from one another;

(b) a diode, fabricated from a semiconductor material for controlling a flow of current,

(1) electrically connected to one of said contact points and

(2) disposed within said container;

(c) a fuse wire, for opening the circuit through said diode should it become shorted,

(1) electrically connected to the other of said contact points and said diode and

(2) disposed within said container;

(d) an indicator held in a first position remote from said transparent portion by said fuse wire; and

(e) means for biasing said indicator toward said transparent portion whereby failure of said fuse wire causes said indicator to move to a second position and be displayed at said transparent portion.

2. A device according to claim 1 wherein said means for biasing comprises a tension spring having a first portion held stationary to said container and a second portion attached to said indicator.

3. A device according to claim 2 wherein said spring and said indicator are the electrical connection between said fuse wire and said diode.

4. A device adapted to be utilized in an electrical circuit comprising:

(a) a container

(1) having a transparent portion and

(2) including at least two electrically conductive contact points insulated from one another;

(b) a diode, fabricated from a semiconductor material for controlling a flow of current,

(1) having one portion electrically connected to one of said contact points and

(2) disposed within said container;

(c) a fuse wire, for opening the circuit through said diode should it become shorted,

(1) having one end electrically connected to another of said contact points and

(2) disposed within said container;

(d) an indicator

(1) fabricated from electrically conductive material and

(2) connected to the other end of said fuse wire whereby it is held in a first position remote from said transparent portion; and

(e) spring means fabricated from electrically conductive material

(1) biasing said indicator toward said transparent portion whereby said indicator will be displayed at said transparent portion upon failure of said fuse wire, and

(2) connected to another portion of said diode to thereby, with said indicator, provide an electrically conductive path from said fuse to said diode.

5. A device adapted to be utilized in an electrical circuit comprising:

(a) a tube fabricated from heat-resistant, transparent material having

(1) layers of opaque material extending inwardly from each end substantially one-third of its length to form a window at substantially the middle one-third of said tube, and

(2) two electrically conductive contact points secured thereto;

(b) a diode, fabricated from semiconductor material for controlling a flow of current,

(1) having first and second externally electrically conductive contact points and

(2) disposed within one end of said tube;

(c) said first external contact point of said diode electrically connected to one of said tube contact points;

(d) a fuse wire, for opening the circuit through said diode should it become shorted,

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- (1) having one end connected to the other of said tube contact points and
  - (2) disposed within the other end of said tube;
  - (e) an indicator
    - (1) fabricated from electrically conductive material and
    - (2) connected to the other end of said fuse wire whereby it is held in a first position hidden from view by the layer of opaque material on the end of the tube in which the fuse wire is disposed; and
  - (f) spring means fabricated from electrically conductive material
    - (1) biasing said indicator toward said transparent window whereby said indicator will be displayed in said transparent window upon failure of said fuse wire, and
    - (2) connected to said second external contact point of said diode to thereby, with said indicator, provide an electrically conductive path from said fuse wire to said diode.
6. A device adapted to be utilized in an electrical circuit comprising:
- (a) an elongated tube of heat-resistant, transparent material having
    - (1) layers of opaque material extending inwardly from each end substantially one-third of its length to form a window at substantially the middle one-third of said tube, and
    - (2) two electrically conductive end caps, one secured to and closing one end of said tube and the other secured to and closing the other end of said tube;
  - (b) a diode, fabricated from semiconductor material for controlling a flow of current,
    - (1) having first and second external electrically conductive contact points

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- (2) secured within said tube to one of said end caps;
- (c) said first external contact point of said diode electrically connected to said one of said end caps;
- (d) a fuse wire, for opening the circuit through said diode should it become shorted, secured within said tube with one end attached to the other of said end caps;
- (e) an indicator,
  - (1) fabricated from electrically conductive material,
  - (2) connected to the other end of said fuse wire whereby it is held in a first position hidden from view by the layer of opaque material on the end of the tube in which the fuse wire is disposed; and
- (f) spring means fabricated from electrically conductive material
  - (1) biasing said indicator toward said transparent window whereby said indicator will be displayed in said transparent window upon failure of said fuse wire and
  - (2) connected to said second external contact point of said diode to thereby, with said indicator, provide an electrically conductive path from said fuse wire to said diode.

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